Deep Learning and Medical Image Processing for Automated Detection of COVID-19 Cases

SYNOPSIS

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Abstract of proposed work plan/ problem

The corona virus disease (COVID-19) outbreak has caused many death cases since December 2019. It has been significantly affected all sectors of human life. In almost countries, it has placed a heavy burden on medical facilities especially those with poor health systems. The huge source digital data of medical images (e.g., X-ray, CT, and MRI) make deep learning a perfect technique to tackle the outbreak of COVID-19. Deep Learning has been implemented in many medical applications including diabetic retinopathy detection, lung nodule classification, fatal localization, and thyroid diagnosis. In the present research work, we will focus on study and analysis of deep learning applications for COVID-19 medical images. Then we will apply Deep Learning methods on COVID-19 database for the quick detection and diagnosis of COVID 19 positive cases through image processing. Chest CT images of novel coronavirus pneumonia will be used as an input for the research work.

1. Introduction

COVID-19 is a new strain of corona virus that has not been previously identified in humans. The COVID-19 is the cause of an outbreak of respiratory illness first detected in Wuhan, Hubei province, China [1]. Since December 2019, growing number of cases have been identified in almost all countries. Corona viruses are a large family of viruses that are known to cause illness ranging from the common cold to more severe diseases.

The mortality rate of COVID-19 is less than that of the severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) corona virus diseases (10% for SARS-CoV and 37% for MERS-CoV). However, it is highly infectious, and the number of cases is continuously rising [2].

In a desperate attempt to tackle with the COVID-19 pandemic, researches have been started with scientific studies in all directions.

In order to find correct solutions, medical image processing methods have also been rigorously investigated and integrated with Deep Learning. The accuracy of the results produced by Machine Learning and Deep learning methods completely depends up on the high-quality large DataSet of images. Also, by incorporating multiple DataSet and integrating those with Deep Learning Models can help to enhance the accuracy of the automatic detection.

2. Review of Literature and development in the subject (previous work done in the relevant area)

Various implementations have been introduced in the literature using Deep Le arning techniques.

Kermany et al. proposed Data Learning framework [3] using transfer learning method to check accuracy, Cross-Entropy Loss, True, Positive Rate and False Positive Rate. This analysis study did not include usage of data source image DataSet to ensure generic usability of the proposed model.

Rajaraman and coworkers [4] proposed a Customized CNN model-VGG16. They have used Random Sampling Process. It was found that reliability of the model in highly non-linear locality pertaining to the predictions was not considered.

Wang Kang and colleagues [5] proposed a framework based on Artificial Intelligence and Deep Learning to measure Accuracy, Specificity and Sensitivity. This study does not include Analysis of the relationship between Hierarchical features of CT images and genetic, epidemiological information.

Shan et al. [6] used DataSet of Chest CT scan image from Shanghai Public Health Clinical Centre, using Human-In-the-Loop Strategy, DL Based Segmentation Network VB Net. Dice Similarity Index, Pearson Correlation Coefficient, Time of Manual Contouring, Segmentation Accuracy has been calculated. Quantification of Imaging Metrics and establishing correlation

between syndromes, epidemiology and treatment responses were not part of the study.

Ghoshal and Tucker [7] have used X-ray Images of Posterior-Anterior (PA) part of the lungs from Dr Joseph Cohen's GitHub repository augmented with Chest X-ray Images from the Kaggle DataSet for the experiment. It has been proposed that the Drop weights-based Bayesian Convolutional Network model for the prediction of Uncertainty and Accuracy.

Apostolopoulos and Mpesiana [8], using X-ray Image DataSet from GitHub and Cohen, Image DataSet from Radio-logical Society of North America (RSNA), Radiopaedia, and Italian Society of Medical and Interventional Radiology (SIRM). Model proposed that Transfer Learning based on Convolutional neural network (CNN), to measure Accuracy, Sensitivity and Specificity. More extensive analysis using larger DataSet and development of models, enhance capability of differentiation between COVID-19 and other viral infectious diseases.

Farooq and Bazaz [9] employed deep learning to propose an Artificial Neural Network (ANN) based and data stream guided real-time incremental learning algorithm for parameter estimation of a non-intrusive, intelligent, adaptive and online analytical model of Covid-19. The proposed non-intrusive algorithm eliminates the need to retrain or rebuild the model from scratch every time a new training DataSet has been received. After validating the model, they used it to study the impact of different strategies for epidemic control. It has been proposed and simulated a strategy of controlled natural immunization through risk-based population compartmentalization (PC) wherein the population has been divided in Low Risk (LR) and High Risk (HR) compartments based on risk factors (like comorbidities and age) and subjected to different disease transmission dynamics by isolating the HR compartment while allowing the LR compartment to develop natural immunity.

Hemdan et al. [10] used X-ray Image Dataset from Dr Joseph Cohen and Dr Adrian Rosebrock COVIDX-Net comprising of Deep CNN Models to calculate Accuracy, Precision, Recall and F1- Score. This study does not focus on in-depth analysis on larger DataSet.

Narin and Coworkers [11] worked on the DataSet X-ray Images from Dr Joseph Cohen GitHub Repository. They Proposed a model called Deep CNN Models -ResNet50, InceptionV3 and Inception-ResNetV2, to measure Accuracy, ROC and Confusion Matrices. This study has not considered the implementation of the CNN Models on larger datasets to enhance classification performance.

3. Statement of the Problem

The pandemic is at its peak and existing medical facilities have been already overwhelmed. The emergency departments, intensive care facilities have been stretched beyond their regular capacity to serve the ever-increasing population of patients. In such a serious situation, the healthcare providers and also the patient family members need to make rapid decisions with minimal information. Also, the extremely critical infected patients are suffering from multi-organ failures.

It is very essential to reduce the mortality rate as fast as possible by using the limited knowledge base and resources. The traditional lab-based RT-PCR (real-time polymerase chain reaction) test or nose- throat swab has limited sensitivity and is also time-consuming tests. It will not be feasible to use this method when patients are huge in number, creating shortage of RT-PCR.

The models based on ML and artificial intelligence (AI) and Deep Learning techniques have the potential to enhance Decision making and improvement in the patient-centric results accuracy with CT and X-ray images.

4. **Objectives of Research**

1. To collect basic information and DataSet on COVID-19 affected patients,
2. To study and understand the role of Deep Learning in medical image processing for the diagnosis of COVID-19 cases,
3. To do comparative study of applied algorithms of deep learning for detection of COVID 19 cases.
4. To propose an automated intelligent system for distinguishing COVID-19 patients from non-patients on the basis of chest X-ray images.

5. **Methodology to be adopted:**

Database for COVID-19

a. COVID-CT-DataSet [12]
b. Cohen JP DataSet [13]
c. Kaggle Repository [14]
d. COVID SemiSeg DataSet [15]
e. COVID 19 Clinical DataSet [16]
f. ICLUS- DB [17]
g. COVID 19 Open Research DataSet [18]

Techniques for Detection of COVID-19

a. Convolution Neural Network (CNN)
b. DarkNet 19
c. VGG
d. Data augmentation and spatial transform Network
e. Deep Neural Network Algorithms
f. nCovNet
g. InceptionV3, Resnet50
h. DenseNet121

Detection of COVID -19 is also possible with other databases and techniques

The proposed research work will be carried out through following steps for automated distinguishing COVID-19 patients from non-patients on the basis of chest X-ray images

a. Collection of Raw Data,
b. Data Fusion by using image processing techniques,
c. Development of Database,
d. Feature extraction ,
e. Preparation of Dataset for training,
f. Training and testing using Deep Learning classification methods,
g. Evaluation of Performance, and
h. The efforts will be made to increase the performance of proposed method.

   The detection process of COVID19 needs to use more terminology for accuracy.

6. Importance of the study

The most common test technique used for COVID-19 diagnosis is a real-time reverse transcription-polymerase chain reaction (RT-PCR). Chest radiological imaging such as computed tomography (CT) and X-ray have vital roles in early diagnosis and treatment of this disease. Currently CT is a sensitive method to detect COVID-19 disease and it can be considered as a screening tool with RT-PCR. The research has found that CT should be used as the primary screening tool for COVID-19. Deep Learning can be applied in variety of domains, which produce huge amount data which is required to be processed quickly and Medical domain is one of them. Deep Learning plays an important role in medical image processing in order to combat the COVID-19 pandemic.

Considering the above view, it is required to develop efficient algorithms using medical image processing and deep learning for automatic detection of

COVID-19 cases using CT images. Proposed technique will help to provide second opinion to expert radiologists in health centres. Proposed algorithm may reduce the workload of clinicians and assist them to make an accurate diagnosis in their daily routine.

7. Proposed work plan

Plan of work and targets to be achieved in first year:

During the first year; an effort will be made to collect DataSet, information related to the present work using different books, research papers and journals. Also, efforts will be made to implement the existing algorithms for the Deep Learning in medical image processing. Two progress reports will be submitted at the end of this year.

Plan of work and targets to be achieved in second year:

During second year, some of the existing algorithms will be implemented on the database and data will be analysed. Improved algorithms will be applied on the database and results obtained will be compared. The research findings will be submitted in the form of two or more research papers to the internal research journals. Two progress reports will be submitted at the end of this year.

Plan of work and targets to be achieved in third year:

During this year, thesis writing will be started and publication of two research papers in reputed journals will be undertaken. Also, the research work will be presented in National/International seminars and conferences.

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